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THE CAROLINA SALT MARSH SNAKE: A DISTINCT FORM OF *NATRIX SIPEDON*

Roger Conant and James D. Lazell, Jr.

Abstract. Hybridization between two species and intergradation between races of one of them has long obscured the nomenclatural status of the water snakes of the *Natrix sipedon-fasciata* group in eastern North Carolina. A study of recently acquired material and the recognition that hybridization is occurring in several localities where fresh- and brackish-water habitats meet make possible a clarification of the confusing *engelsi* situation. Because the name *engelsi* was inadvertently applied to a snake of the wrong species, a taxonomic adjustment is made and the name *Natrix sipedon williamengelsi* is erected for the salt marsh snake that occurs on several of the islands of North Carolina's Outer Banks and along the mainland perimeter of Pamlico Sound and associated estuaries.

INTRODUCTION

The confusing status of the water snakes of the *Natrix sipedon* complex from the Outer Banks of North Carolina and the adjacent mainland has long intrigued both of us. Conant (1963: 29–32) summarized much of the data available at that time under the heading of "brackish-water populations." Lazell, as part of studies on the biota of the Banks, has recently accumulated considerable fresh material that helps to throw light on the situation. We have deemed it advisable to pool our knowledge and resolve the "*engelsi*" problem, which we review in some detail.

Three recognizable forms of the *Natrix sipedon-fasciata* group occur in eastern North Carolina. *Natrix sipedon* and *Natrix fasciata* are distinct species, based on their wide sympatry in the Mississippi Valley, along the Gulf Coast, and in northeastern North Carolina (Conant, *ibid.*). In the Carolinas *fasciata* is confined almost exclusively to freshwater habitats on the Coastal

Plain; *sipedon* occurs in the mountains and Piedmont, but it also invades the Coastal Plain north of Albemarle Sound, occurs on the peninsula between Albemarle and Pamlico Sounds, enters and is quite tolerant of brackish-water conditions bordering Pamlico and Core Sounds, and also occurs on the islands of the Outer Banks. In much of this general area it is differentiated at the subspecific level, thus providing the third form of the complex from eastern North Carolina.

That peculiar specimens of *Natrix sipedon* occur on the Outer Banks is a view scarcely novel with us. Barbour (1943) described *Natrix sipedon engelsi* on the basis of a single individual taken from Mullet Pond on the Shackleford Banks. Mullet Pond, which was formerly a bay on the north shore of the island (Engels, 1952: 704), now has no connection with salt water and is fresh; it supported a dense stand of cattails *(Typha)* and there was very little open water when a field party of the American Society of Ichthyologists and Herpetologists visited it on 5 September 1964. The snake Barbour used for his type (MCZ 46688) unfortunately is identifiable as *Natrix fasciata.* We have examined this specimen both independently and together, and we agree that from all diagnostic morphological characters it is a *fasciata.* The name *engelsi,* therefore, should be relegated to the synonymy of *fasciata,* a view previously suggested by Conant (1961: 19).

The history of the description of *engelsi* is of considerable interest, and we quote from a letter that Dr. William L. Engels sent to the senior author under the date of 27 February 1962: "Dr. Barbour spent a few days in Chapel Hill in May 1942 . . . . Dr. Coker brought him around to me. I was just finishing the manuscript for my report on the Ocracoke fauna, and I showed him the king snake I had from there which was certainly a peculiar looking, chocolate-colored individual. I also showed him the only other live snake I had, the rat snake from Shackleford Banks. He immediately got quite excited, came back the next day and stared at those snakes some more, and wanted me to sit down immediately to describe them as new. I was about to go into the Air Force, did not have any comparative material, and at any rate was totally lacking in experience in systematic herpetology. The end of it was that I sent him the snakes and went myself into service. He wrote me proposing that either my name should be given to one of them or that my name should be put on the descriptions as joint author. I agreed to the latter, and that ended our collaboration. I deliberately did not show him the water snakes— I thought that was a little project I could keep for myself, for after the war (they did strike me as being unusually dark). But Dr. Coker did not know this. He did know that Dr. Barbour had become quite excited about 'the new herpeto fauna' which I 'had discovered' — the quotes are Barbour's words. So, having come into possession of a *Natrix* from the Mullet Pond on Shackelford, while I was in Egypt, he sent it to Barbour. That became the type of *N. s. engelsi.*"

The practice of describing new taxa from single specimens, although always potentially risky, was widespread 30 years ago. Consideration should also be given to the fact that Barbour was an alpha taxonomist; he seldom examined large series of specimens, and he was accustomed to describing new species from islands of the West Indies. It is understandable that he could engender strong enthusiasm about unusual insular specimens. His type of *engelsi*, a very dark snake in which black pigment obscures many of the pattern details, is now known to be a representative of a deme inhabiting Mullet Pond that shows strong evidence of hybridization between *sipedon* and *fasciata*. As is noted below, some of the snakes of this population are morphologically indistinguishable from *sipedon*, others could be identified as *fasciata*, and others combine characters of both. This phenomenon is not unique to the Shackleford Banks. It also occurs at other places where fresh- and saltwater habitats meet and in a few localities within the Fall Line zone of both the Carolinas and Georgia (Conant, 1963).

In an effort to end the confusion that has thwarted a real understanding of the *Natrix sipedon-fasciata* complex of the region for three decades, we take pleasure in describing:

NATRIX SIPEDON WILLIAMENGELSI n. ssp.

Holotype. MCZ 129298, a young adult male, collected by Paul Elias, 14 June 1971, along Island Creek on Ocracoke Island, Hyde Co., North Carolina.

Paratypes. (All from North Carolina.) CORE BANKS, *Carteret Co.*: North Carolina State Museum (NCSM) 11796, MCZ 131993, Cape Lookout. HATTERAS ISLAND, *Dare Co.*: United States National Museum (USNM) 72573; MCZ 130278–79, Hatteras Village. OCRACOKE ISLAND, *Hyde Co.*: MCZ 129290, Horse Pen Creek; MCZ 129299, 129302, Island Creek; MCZ 129242, between Island Creek and Pamlico Sound; MCZ 131990–91, Ocracoke Village; MCZ 131988, Quork Hammock; MCZ 129288, 129300, Quorks Point Creek; MCZ 129249, Old Hammock Creek; MCZ 129250, Pony Pasture Creek; NCSM 11798, 1 mi. W of The Knoll; NCSM 11797, Try Yard Creek. PORTSMOUTH ISLAND, *Carteret Co.*: MCZ 129251–74, 129289, Portsmouth Village. MAINLAND: *Carteret Co.*: NCSM 8003, 11 mi. S of Merrimon; MCZ 131992, SW part of Cedar Island. *Hyde Co.*: American Museum of Natural History (AMNH) 88076, Rose Bay Creek. *Pamlico Co.*: AMNH 88075, Oyster Creek near Lowland.

Diagnosis. A strongly melanistic race of *Natrix sipedon* in which: (1) the dorsum in adults is essentially black with the interspaces between the crossbands and blotches so dark that pattern details often can be discerned only if the specimen is immersed in liquid; (2) the venter posterior to midbody is predominantly black; (3) there are no reddish- or brown-centered ventral crescents or half-moons posterior to the 50th ventral; and (4) the light scales between the dark crossbands average one and one-half (maximum three) on the neck at the level of the second dorsal scale row.

Description of the type. MCZ 129298 is a young adult male 725 mm in total length; the tail is complete and measures 168 mm. There are 138 ventrals, 72 subcaudals, and a maximum of 23 dorsal scale rows. The anal is divided and both hemipenes are everted. The general coloration is black with dull gray interspaces between the black bands and blotches. The interspaces vary, at the level of the second dorsal row, from one to two scales in width; most are about a scale and one-half. The dark dorsal bands are continuous, from ventral edge to ventral edge across the anterior part of the body; they are replaced posteriorly by alternating lateral bars and middorsal blotches, as in the nominate race. The entire snake is so dark that the pattern is most clearly observed under liquid.

The ventrals are virtually uniformly black at the posterior end of the body, but are lightly spotted with white; the white spots are larger and much more prominent on the anterior third of the body. There are no reddish- or brown-centered ventral crescents posterior to ventral 48.

Variation. We have examined 50 specimens of this race (26 males and 24 females). Of these, the senior author examined three alive, the junior author more than 20 alive or freshly killed on the road. The very dark coloration of *williamengelsi* is little affected by preservation, and there is far less variation than in the nominate race. All specimens are black or dark brownish black with very narrow, lighter, grayer interspaces between the dark bands. The bands are so wide relative to the interspaces that most individuals appear uniformly black in the field. One specimen (MCZ 131990) from Ocracoke Village was aberrantly red. The areas normally white or gray, ventrally and laterally, were rose or rusty. There were, however, no red-centered crescents posterior to ventral 44.

Many specimens show an indication of the pale vertical bar that crosses the angle of the jaws as illustrated in Conant (1963, fig. 6E). This is frequent in *Natrix sipedon* from southern coastal localities, and usually quite different from the pale longitudinal stripe of *Natrix fasciata* (Conant, 1963, fig. 6F).

Most specimens have red- or brown-centered ventral crescentic markings on the anterior venter; the most posterior of these vary in position from ventral six to ventral 48. Very young specimens, such as MCZ 129252–74, from Portsmouth, Portsmouth Island, have no red- or brown-centered ventral crescents at all.

Scale characters are of little use in distinguishing *Natrix fasciata* from *Natrix sipedon sipedon* (Conant, 1963: 11–15), and they are of no value in separating *williamengelsi* from the nominate race of *sipedon*. Overall variation in *williamengelsi* is as follows: ventrals 129–143, mean 138 (females 133 to 143, mean 138; males 129 to 143, mean 137); subcaudals 57–84, mean 70 (females 57–70, mean 64; males 62 to 84, mean 75); maximum number of dorsal scale rows in both sexes 21–23 (among the 50 specimens, only six vary from 23 — three have 22 and three have 21).

Size. Our largest specimen (MCZ 129290, a female from near Horse Pen Creek in the "Up Trent" region of Ocracoke Hammock, collected 16 June 1971, by Numi C. Spitzer) measured 1224± mm (48 in.) in life. This snake is illustrated in Figure 1. The smallest specimen examined is 139 mm in total length. This snake (a male) is the runt of a litter of 24 the rest of which vary from 193 mm to 216 mm (mean 204 mm). These are young of a female (MCZ 129251) from Portsmouth, Portsmouth Bank, that measures 1040 mm, total length, and has a stump tail 125 mm long.

Comparisons. Melanism occurs sporadically in several parts of the range of the nominate subspecies *(sipedon)*. Occasional individuals of that widely distributed complex may be as dark dorsally as typical specimens of *williamengelsi*, and some large adults may be almost plain black or very dark brown. Ventrally, however, there is great variation in such dark snakes. In some, the under surface may be virtually plain black, but in others there may be bold black half-moons with or without deep red centers, a longitudinal midventral stripe of white, yellow, orange, or red may be present, or the entire belly may be dusted with gray or black, etc. Among the many thousands of specimens of *N. s. sipedon* that we (collectively) have examined, we have never encountered a melanistic population that combines all four diagnostic characteristics of *williamengelsi.* Melanism in other populations is local or restricted to a few individuals, usually large adults.

INTERGRADATION

Intergradation between *williamengelsi* and nominate *sipedon* is extensive. The fresh- and brackish-water marshes of Pea Island, which is the northern end of Hatteras Island, and on Bodie Island, just north of Oregon Inlet, have yielded a considerable number of specimens from intergradient populations. Among 13 from the Bodie Island marshes, five appear to be typical *sipedon,* four are indistinguishable from *williamengelsi,* and four are intermediate.

Among 27 specimens from Pea Island, eight show the pattern characteristics of *sipedon,* six those of *williamengelsi,* and the other 13 are intermediate. We have 11 additional specimens from the zone of intergradation between *sipedon* and *williamengelsi.* A specimen from east of Manteo, Roanoke Island, is virtually typical *N. s. sipedon*; another from the same locality is close to *williamengelsi.* Of two from Waves, Hatteras Island, one is intermediate, the other virtually *williamengelsi.* A specimen taken eight miles north of Avon, Hatteras Island, has all the characteristics of *williamengelsi.* Another, from 4.3 miles north of Buxton, Hatteras Island, is typical of *N. s. sipedon.* From the Buxton area, the southernmost limit of the zone of intergradation, one specimen appears to be typical of *sipedon,* two are typical of *williamengelsi,* and two are intermediate. Two specimens from Hatteras Island, without precise data, but presumably from north of Hatteras Village, are *N. s. sipedon* in most characters. A specimen from Creed's Hill, Frisco, within the Buxton Woods region but well west of Buxton proper, is intermediate.

We consider the following preserved specimens (all from Dare Co., North Carolina, except as indicated) to be intergrades between *Natrix sipedon sipedon* and *N. s. williamengelsi*: BODIE

ISLAND: AMNH 108839, 108842–50; Duke University collection (DU) 288. HATTERAS ISLAND: MCZ 129294, 8 mi. N of Avon; DU 227, 229, and MCZ 129296, Buxton; MCZ 129293, 4.3 mi. N of Buxton; NCSM 11800, Cape Hatteras; DU 228, Creed's Hill; USNM 72571–72, NE of Hatteras Village; DU 242, and MCZ 129301, Waves. PEA ISLAND: AMNH 108835, 108837–38, 108840–41, 108851–64 and MCZ 129309–10; DU 231, 1/4 mi. S of Oregon Inlet; DU 226, 230, 2 mi. S of Oregon Inlet; MCZ 129295, 4 mi. N of Rodanthe. ROANOKE ISLAND: Carnegie Museum (CM) 23074, E of Manteo; DU 120, 2 mi. SE of Manteo. MAINLAND: *Hyde Co.*: AMNH 89149, Engelhard.

Another specimen of *Natrix sipedon sipedon* is now available from the peninsula between Pamlico and Albermarle Sounds, an area in which members of this taxon apparently are quite uncommon. This is NCSM 11475 from Slades Creek, near Sladesville, Hyde County. The only other specimen of the nominate race reported from the peninsula is AMNH 43427 from Lake Phelps (Conant, 1963: 26).

HYBRIDIZATION

Hybridization with *Natrix fasciata* is also a major feature of *N. s. williamengelsi* biology. An apparently typical but exceptionally dark female *Natrix fasciata*, from Ponzer, on the Hyde County mainland (AMNH 88077), produced a litter (AMNH 88078–101) that exhibits a variety of characteristics ranging from those of the mother *(fasciata)* to those of typical *N. s. williamengelsi.* The pale marking passing through the angle of the jaws matches the vertical bar of *Natrix sipedon* in some, whereas in others it is comparable with the longitudinal stripe of *Natrix fasciata.* The dorsal markings vary from the posteriorly staggered middorsal and lateral bars of *sipedon* to the bands that are continuous throughout the length of the body in *fasciata.* All members of this litter are very dark. (See Conant, 1963: 30, for further details.) The mother, as noted, is a very dark *N. fasciata*; we do not know the relevance of visual cues in mate selection in these forms of *Natrix*; perhaps they are important.

A hybrid swarm occurs at Mullet Pond, on the Shackleford Banks, in a freshwater ecosystem of largely mainland ecological affinities. Among 22 specimens from Mullet Pond, four (including MCZ 46688, the type of *"engelsi"*) are morphologically typical of *Natrix fasciata,* three are more or less typical of *wil-*

liamengelsi, and the others, including young from three litters and totalling 15 specimens, are intermediate. Snakes from Mullet Pond, Shackleford Banks, are: AMNH 75800–04 + 13 untagged; DU 10, 234; California State University, Long Beach (CSULB) 263–64.

Apart from the Ponzer litter and Mullet Pond specimens, we have examined one other snake from the North Carolina mainland which is apparently a hybrid. It is NCSM 11799 from Lennoxville Point, 3 miles east of Beaufort, Carteret County.

We are of the opinion that much of the apparent introgression manifest along the shores of Pamlico Sound and associated bodies of water is a direct consequence of the massive disturbance of habitats by the great cyclonic storms that sweep ashore rather frequently in eastern North Carolina. To visit the marshes after a hurricane, as Lazell did, following Ginger in early October, 1971, is to see convincing evidence that salt water can be driven far inland by winds and tides. Conversely, as the result of torrential rains, vast quantities of fresh water move seaward after each tempest has passed, carrying many animals and plants of the freshwater biota with them on debris borne by the flood. Some of these organisms certainly must make landfalls in the salt marshes. Mayr, Linsley, and Usinger pointed out long ago (1953: 102) that hybridization between related species may occur in localities where the natural ecological balance has been badly disturbed by human interference. Conant (1963: 16–23) marshalled evidence indicating introgression between *sipedon* and *fasciata* along the Fall Line in the Carolinas where mankind has been active. Surely hurricanes are equally disturbing to the ecological balance, at least in some localities.

The distribution of specimens examined is shown in Figure 2. We have made no attempt to show localities for *Natrix fasciata*. which probably occurs in virtually every body of fresh water on the adjacent mainland. Some specimens on which we report patterns and scale counts are not included on our lists. A few snakes were discarded because of their poor condition, and one escaped near where it was collected.

ECOLOGY

Natrix sipedon williamengelsi is closely associated with marsh grasses of the genus *Spartina* and the rush, *Juncus*, wherever these form salt and brackish marshes. On Ocracoke Island, *williamengelsi* is common in salt marshes adjacent to Pamlico Sound, along the tidal creeks that carry brackish water among the dunes, and also in the fresh water of land-locked ecosystems such as that which occurs at Island Creek. The density of the water where some of the snakes were collected varied from that of the Sound proper, 1.018, to Island Creek at .999. The density at five collecting stations sampled in May and June, 1971, ranged from 1.007 to 1.015; the average density was 1.013.

The relation of density to salinity is dependent on temperature. The water samples taken at the times the snakes were collected varied from 25° to 29°C; the average was 27°C. Salinities of seven habitats sampled (including the Sound, Island Creek, and the above five) varied, therefore, from 2.7 to 24 grams per kilogram; the average was 20.5 g/kg.

In the laboratory, specimens of *N. s. williamengelsi* fed voraciously on the minnow, *Fundulus heteroclitus*, the frogs, *Hyla cinerea*, *Hyla squirella*, and *Rana pipiens*, and the toad, *Bufo fowleri*. All of these are abundant on Ocracoke. We have the impression that these snakes will eat almost any fish or amphibian small enough to swallow, as is also the case with the nominate race. Even after a full week of water starvation, our captives would not drink salt water, but they eagerly drank fresh water. Pettus (1963) obtained similar results with Gulf Coast salt marsh snakes, *Natrix fasciata clarki*.

N. s. williamengelsi is a favorite prey of marsh hawks, *Circus cyaneus*, and is no doubt taken by other raptors. The numerous species of egrets and herons that frequent the Carolina salt marshes in all probability eat these snakes regularly, but we have not observed this. Many specimens have mangled or abbreviated tails that suggest predation by birds or the crabs that are common in the habitat.

The junior author, on field trips over several years, has found *N. s. williamengelsi* abundant from May to September in the optimal habitats south of Cape Point, Hatteras Island, on the Outer Banks. In the Buxton Woods area, north and west of Cape Point, *Agkistrodon piscivorus* is common, but it is not known from the Banks to the southward, at least to Cape Lookout. *Natrix sipedon* is scarce in the Buxton Woods area, where it may fall prey to the cottonmouth.

The only other water snake known from the Outer Banks is *Natrix taxispilota*; it is confined to fresh water in the Buxton Woods area, and is scarce.

It should be pointed out that a large part of the range of *N. s. williamengelsi* is within National Park borders. The blanket protection provided for all animals includes this snake. Collecting is illegal within the Cape Hatteras National Seashore, except by specifically designated Park Service employees.

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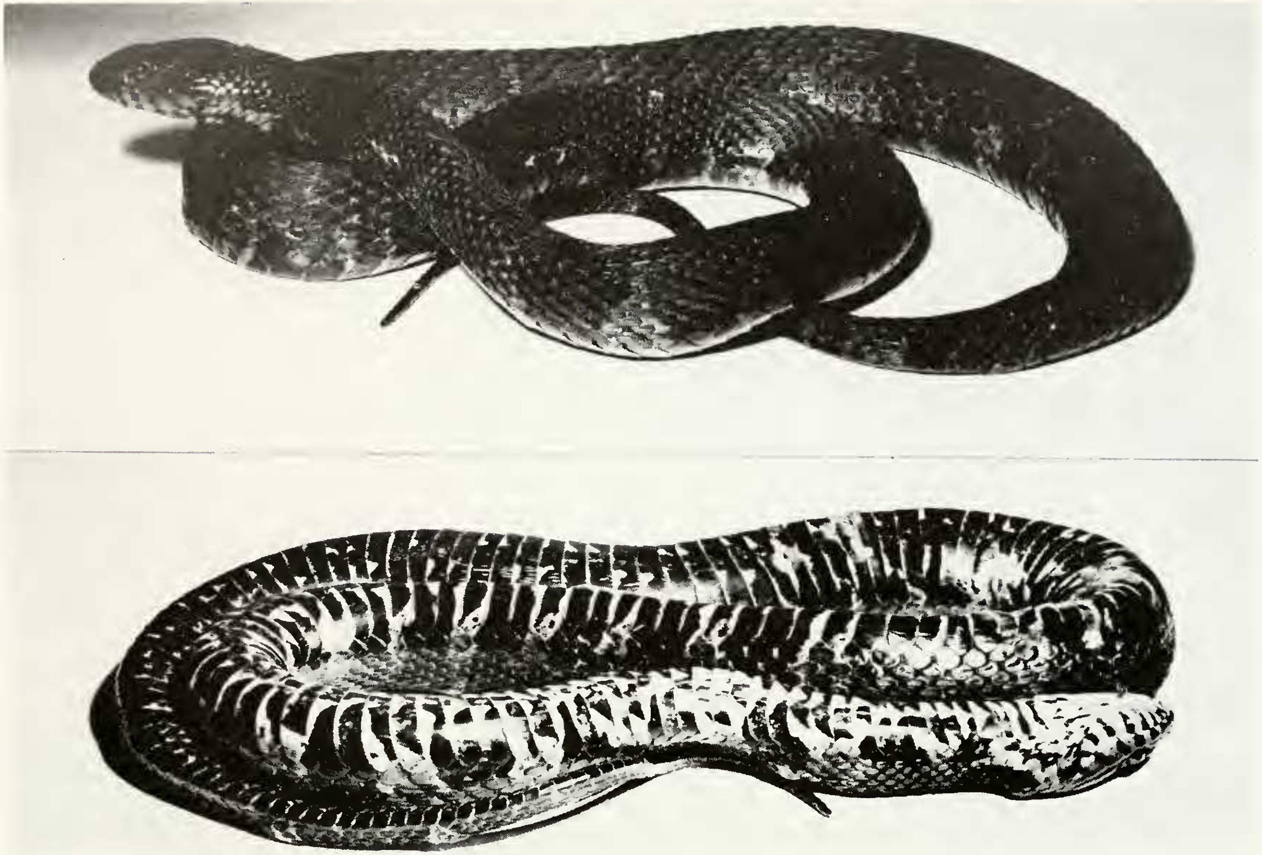

Figure 1. Carolina Salt Marsh Snake, *Natrix sipedon williamengelsi* (MCZ 129290). A large adult female from near Horse Pen Creek in the "Up Trent" region of Ocracoke Hammock, Ocracoke Island, Hyde Co., North Carolina. Total length 1224 mm. Upper: Dorsal view. Lower: Ventral view. Photos by Isabelle Hunt Conant.

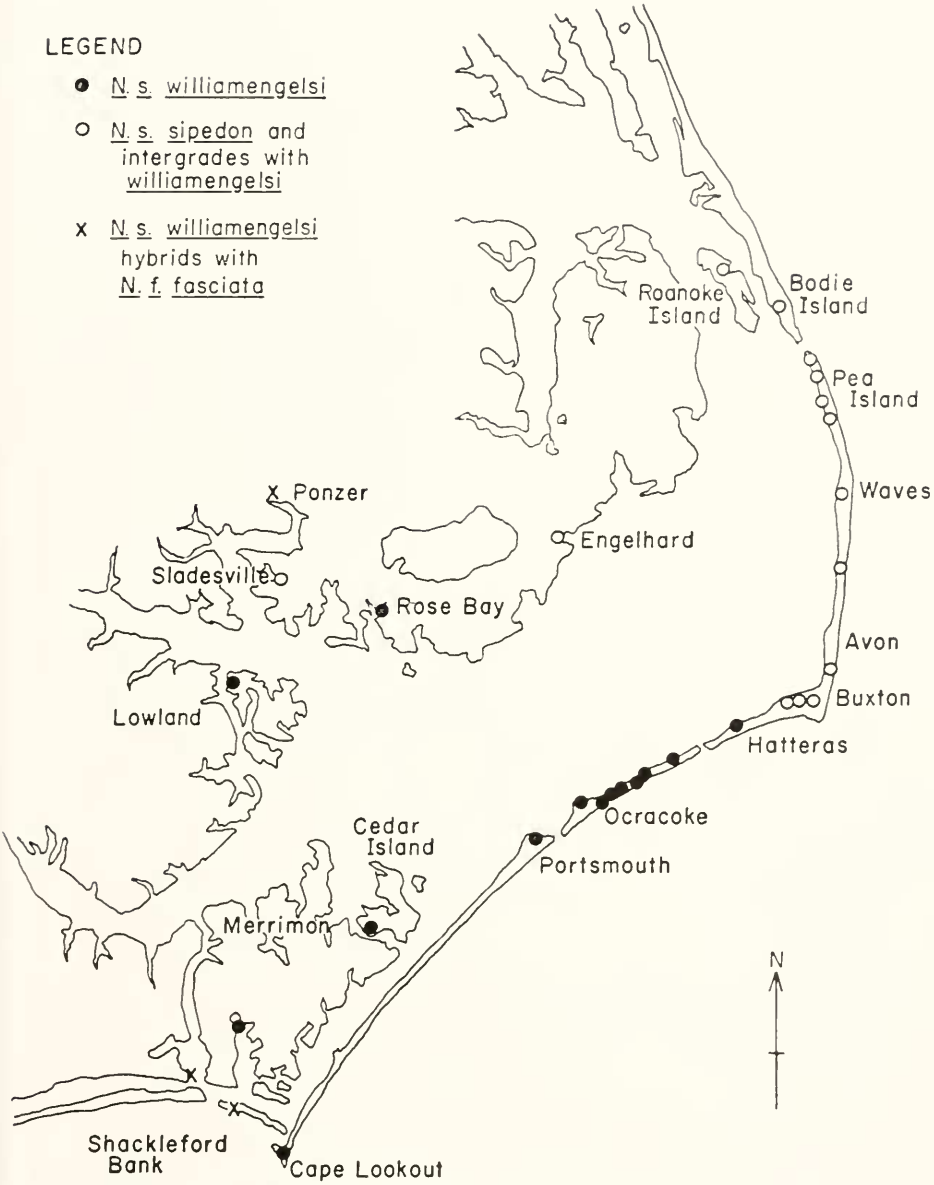

Figure 2. Map showing distribution of *Natrix sipedon williamengelsi* and intergrades between it and *N. s. sipedon* and hybrids between *williamengelsi* and *N. fasciata fasciata*.